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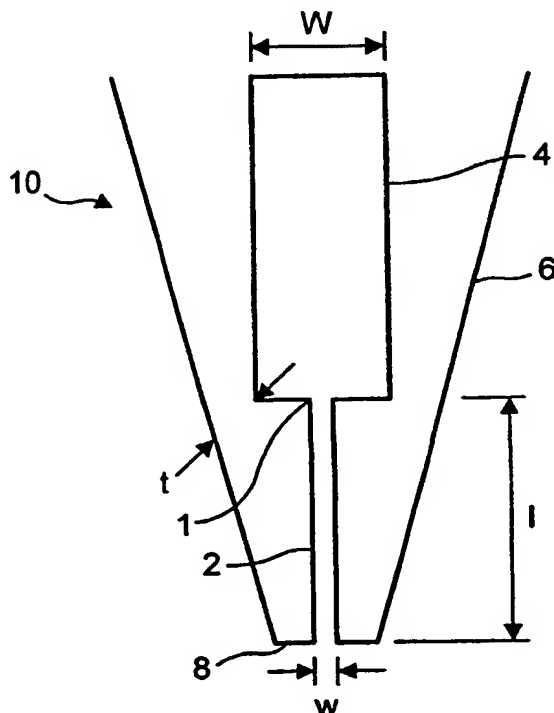
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(54) Title: LIQUID TRANSFER PIN



(57) Abstract: A method of producing a liquid transfer pin (10) having a tip (8) and defining a slot (1) extending from the tip (8) for transferring one or more drops of a fluid to a substrate, the slot comprising an elongate outlet portion (12) extending from the tip (8) and a reservoir portion (4) connected to a distal end of the outlet portion and having a larger cut-out volume than that of the outlet portion, said method comprising the step of cutting the slot into a tip of a solid pin, wherein the width of the outlet portion at the tip is no more than 20 microns directly after cutting.

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# INTERNATIONAL SEARCH REPORT

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**A. CLASSIFICATION OF SUBJECT MATTER**  
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According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B01L GO1N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.                       |
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.                       |
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Information on patent family members

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## LIQUID TRANSFER PIN

The present invention relates to a liquid transfer pin for transferring one or more drops of fluid to a substrate, and to a method of producing such a pin, and in particular, to a liquid transfer pin for producing microarrays of droplets for testing in the field of life sciences, and to a method of producing such a liquid transfer pin.

Molecular biologists have a need to be able to create an array of thousands of different fluidic samples on a microscope slide or other substrate. Such arrays are typically prepared using a liquid transfer tool. The tip of the liquid transfer tool is dipped into a relatively large volume source of the sample liquid (typically 5 to 40 microlitres) to pick up a droplet on the tip of the tool. The tip of the liquid transfer tool is then contacted with the substrate to transfer the droplet to the substrate. In the case that an array comprising dots of different sample fluids is to be prepared, the above procedure is repeated the necessary times to give the desired number of spots of the first sample fluid; the tool is then cleaned; and then the whole procedure is repeated for each of the plurality of sample fluids.

These liquid transfer tools are typically combined in groups attached to a common base to provide a multi-pin liquid transfer tool so that a plurality of droplets can be transferred to the substrate in a single movement of the base to form an array.

The array-forming process can be further expedited by providing the liquid transfer tool with a reservoir which

is connected to the tip of the liquid transfer tool and which can hold enough of the sample fluid for transferring a plurality of droplets to one or more substrates. The provision of such a reservoir greatly reduces the number of moves the liquid transfer tool needs to make between the substrate(s) and the sample fluid source.

Monolithic liquid transfer tools prepared by the micro-machining of solid pins are known. A slot extending from the tip of the pin is cut into the pin using wire electronic discharge machining (EDM). The smallest slots that have been produced with this technology are slots having a width in the range of 30 to 40 microns.

There has however been a demand for a liquid transfer tool having smaller slot widths for creating an array of droplets of yet smaller diameter in order to create an array of yet greater droplet density. This demand has been somewhat met by modifying the monolithic liquid transfer pins mentioned above by plastic deformation of the tip of the pin to reduce the width of the slot at the tip of the pin from the machined width of 30 to 40 microns to a smaller width.

Such plastic deformation has generally been carried out in the following ways with reference to Figures 7(a), 7(b), 8(a) and 8(b) of the accompanying drawings. According to one approach, the pin is machined with the aim of producing a perfect point as shown in Figure 7(a). The pin is then deformed in the manner generally shown in Figure 7(b) when the tip of the pin is first tapped on the substrate. This method is particularly uncontrolled

and results in some pins which become deformed to the extent that they no longer work.

According to a another approach, the pin is machined to have an increased tip diameter as shown in Figure 8(a). The pin is then plastically deformed before use by a crimping operation or with a screw arrangement to produce an axially tapered slot having a narrowed exit at the tip.

However, the inventors of the present invention have found that these plastic deformation processes are inherently inconsistent resulting in pins of varying slot widths and tip diameters. As mentioned above, multi-pin liquid transfer tools require a group of liquid transfer pins having uniform dimensions in order to produce an array of uniformly-sized droplets, and a lot of time and effort is therefore required to select pins having matching dimensions.

An aim of the present invention is to provide a liquid transfer pin and a method of producing a liquid transfer pin which at least partially resolves the above-mentioned problems in the prior art.

According to a first aspect there is provided a method of producing a liquid transfer pin having a tip and defining a slot extending from the tip for transferring one or more drops of a fluid to a substrate, the slot comprising an elongate outlet portion extending from the tip and a reservoir portion connected to a distal end of the outlet portion and having a larger cut-out volume than that of the outlet portion, said method comprising the step of producing the pin by a non-deformation process, such as



cutting, wherein the width of the slot at the tip of the pin directly produced by the non-deformation process is no more than 20 microns.

According to a second aspect of the present invention, there is provided a method of producing a liquid transfer pin having a tip and defining a slot extending from the tip for transferring one or more drops of a fluid to a substrate, the slot comprising an elongate outlet portion extending from the tip and a reservoir portion connected to a distal end of the outlet portion and having a larger cut-out volume than that of the outlet portion, said method comprising the step of cutting the slot into a tip of a solid pin, wherein the width of the outlet portion at the tip is no more than 20 microns directly after cutting.

According to a third aspect of the present invention, there is provided a method of producing a liquid transfer pin having a tip and defining a slot extending from the tip for transferring one or more drops of a fluid from the tip to a substrate, the slot comprising an elongate outlet portion extending from the tip and a reservoir portion connected to a distal end of the outlet portion and having a larger cut-out volume than that of the outlet portion, said method comprising using copper vapour laser cutting to form the slot in a tip of a solid pin.

According to a fourth aspect of the present invention there is provided a liquid transfer pin produced by any of the above-described methods.

According to a fifth aspect of the present invention there is provided a liquid transfer pin for transferring one or more drops of a fluid to a substrate from a tip thereof, the liquid transfer pin defining a slot extending from the tip, wherein the slot comprises an elongate outlet portion extending from the tip, and a reservoir portion connected to a distal end of the outlet portion, the width of the reservoir portion being greater than the width of the outlet portion at the point where it is connected to the outlet portion.

According to a sixth aspect of the present invention, there is provided a liquid transfer pin for transferring one or more drops of a fluid to a substrate from a tip thereof, the liquid transfer pin defining a slot extending from the tip, wherein the slot comprises an outlet portion extending from the tip and having a substantially axially uniform width, and a reservoir portion connected to the distal end of the outlet portion and having a substantially axially uniform width, the width of the outlet portion being less than the width of the reservoir portion.

According to a seventh aspect of the present invention, there is provided a liquid transfer pin for transferring one or more drops of a fluid to a substrate from a tip thereof, the liquid transfer pin defining a slot extending from the tip, wherein the slot comprises an outlet portion extending from the tip and having a substantially axially uniform width of less than 20 microns, and a reservoir portion connected to a distal end of the outlet portion and having a larger capacity than the outlet portion.

According to an eighth aspect of the present invention, there is provided a multi-pin liquid transfer tool comprising a plurality of liquid transfer pins as described above.

According to a ninth aspect of the present invention, there is provided a method of producing a multi-pin liquid transfer tool by attaching a plurality of liquid transfer pins to a common base, each liquid transfer pin having a tip and defining a slot extending from the tip, wherein each liquid transfer pin is produced by cutting a slot into a tip of a solid pin, the width of the slot at the tip being less than 20 microns directly after cutting.

According to an tenth aspect of the present invention, there is provided a method of producing a multi-pin liquid transfer tool by attaching a plurality of liquid transfer pins to a common base, each liquid transfer pin having a tip and defining a slot extending from the tip, wherein each liquid transfer pin is produced by cutting a slot into a tip of a solid pin by copper vapour laser cutting.

According to a eleventh aspect of the present invention, there is provided a multi-pin liquid transfer tool produced by either of the above-described methods.

According to a twelfth aspect of the present invention, there is provided a method of producing an ordered array of spots on a substrate using a liquid transfer pin or a multi-pin liquid transfer tool as described above.

According to a thirteenth aspect of the present invention there is provided a method of transferring one or more drops of liquid to one or more substrates using a liquid transfer pin, wherein the liquid transfer pin has a tip and defines a slot extending from the tip and is produced by cutting a slot into a tip of a solid pin, wherein the width of the slot at the tip is no more than 20 microns directly after cutting.

According to a fourteenth aspect of the present invention, there is provided a method of transferring one or more drops of liquid to one or more substrates using a liquid transfer pin, wherein the liquid transfer pin has a tip and defines a slot extending from the tip and is produced by cutting a slot into a tip of a solid pin by copper vapour laser cutting.

According to a preferred embodiment of the above-described aspects of the present invention, the slot extends right through the pin in a direction perpendicular to the longitudinal axis of the pin. In an alternative embodiment, all or a part of the slot may only extend partially through the pin in a direction generally perpendicular to the longitudinal axis of the pin, i.e. may only be open on one side in a direction perpendicular to the axis of the pin.

Embodiments of the present invention will be described hereunder, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 shows a schematic cross-sectional view of the working end of a liquid transfer pin according to an embodiment of the present invention;

Figure 2 is a graph showing the performance of liquid transfer pins according to embodiments of the present invention with respect to consistency of volume dispensed;

Figure 3 shows a schematic perspective view of the working end of the liquid transfer pin shown in cross-section in Figure 1; and

Figures 4(a) and 4(b) are schematic cross-sectional views taken through lines A-A and B-B in Figure 3, respectively.

Figures 5(a) and 5(b) are cross-sectional views of the kind shown in Figures 4(a) and 4(b) for an alternative embodiment of the liquid transfer pin according to the present invention.

Figure 6 shows a multi-pin liquid transfer tool according to the present invention.

Figures 7 and 8 schematically show the plastic deformation processes used in the prior art.

Figures 9(a) and 9(b) are schematic cross-sections of an alternative embodiment of a liquid transfer pin according to the present invention, taken perpendicular to the longitudinal axis of the pin.

A liquid transfer pin having the geometry generally shown in Figures 1 and 3 is produced according to the following method. A 5mm diameter solid bar of 17-04ph stainless steel is turned, where necessary, and sharpened at one

end to produce a tapered solid pin having the desired dimensions. Copper vapour laser cutting is then used to cut a slot 1 in the tip of the solid pin 6 which extends from the tip 8 of the pin 6 in a direction substantially parallel to the longitudinal axis of the pin 6. As shown in Figures 3, 4(a) and 4(b), the slot extends right through the pin in a direction perpendicular to the longitudinal axis of the pin 6 (i.e. the direction shown by the arrows in Figures 4(a) and 4(b)).

However, as mentioned above, the present invention is not limited to pins in which the slot extends right through the pin, but includes pins in which the outlet portion and/or the reservoir portion only partially extend through the pin in a direction perpendicular to the longitudinal axis of the pin, i.e. are only open on one side in a direction perpendicular to the longitudinal axis of the pin. Figures 9(a) and 9(b) are schematic cross-sectional views of a liquid transfer pin according to the present invention having a slot comprising an outlet portion 20 and a reservoir portion 22 which only extend partially through the pin in a direction generally perpendicular to the longitudinal axis of the pin. Such an alternative construction can be advantageous in the cases of pins having particularly small tip diameters, since it provides the pin with increased mechanical strength against deformation upon use.

The slot comprises an outlet portion 2 having a substantially axially uniform width and a reservoir portion 4 having a substantially axially uniform width which is larger than that of the outlet portion 2.

The term "substantially axially uniform width" refers to the feature that the width of the respective portion of the slot is substantially uniform along the longitudinal (axial) length of the respective portion of the slot, i.e. from the proximal end to the distal end of the respective portion of the slot.

As shown in the cross-sections shown in Figures 4(a) and 4(b), the slot produced by copper vapour laser cutting has a width which is slightly tapered in a direction generally perpendicular to the axis of the liquid transfer pin, i.e. the direction shown by the arrows in Figures 4(a) and 4(b). In the case of such a slot whose width is not uniform in a direction generally perpendicular to the longitudinal axis of the pin, the term "width" refers to the average width of the respective portion of the slot in the direction shown by the arrows shown in Figures 4(a) and 4(b). As already mentioned above, the average width of the respective portions of the slot is nevertheless substantially uniform along the axial length of the respective portions of the slot, i.e. from the proximal end to the distal end of the respective portions of the slot.

According to an alternative embodiment, the width of the outlet portion and the reservoir portion of the slot are, as shown in Figures 5(a) and 5(b), also uniform in the direction perpendicular to the axis of the pin, i.e. the direction shown by the arrows in Figures 5(a) and 5(b). In this alternative embodiment, the opposing walls of the outlet portion 2 and reservoir portion 4 are thus substantially parallel to each other.

The copper vapour laser cutting is carried out as follows. The solid pin is secured on a mount in the path of the laser beam. The mount is moveable in x and y directions perpendicular to each other and perpendicular to the path of the laser beam. The beam of the laser is focussed down to a dot size of about 5 microns to achieve a sufficient power density to vaporise the material of the solid pin. The laser is then pulsed whilst displacing the pin in the x and y directions by moving the mount to successively vaporise and remove a surface layer of dimensions corresponding to those of the desired slot. This process is repeated to remove successive surface layers until the pin has been cut right through to leave a slot of the desired dimensions in the tip of the pin.

In the case of producing a pin in which the slot only partially extends through the pin in a direction generally perpendicular to the longitudinal axis of the pin, the laser cutting is only continued until a slot of the desired depth has been cut.

One of the advantages of copper vapour laser cutting is that the pulsing can be carried out at a high frequency, whereby a large amount of material can be vaporised and eliminated in a short period of time. This reduces the time required to produce the slot of desired shape.

The geometry of the resulting monolithic liquid transfer pin 10 is generally shown in Figures 1, 3, 4(a) and 4(b). The outlet portion 2 preferably has a width,  $w$  of no more than 20 microns, preferably in the range of 10 to 20 microns, and further preferably in the range of 10 to 15 microns; and the reservoir portion preferably has a



width,  $W$  in the range of 50 to 300 microns, such as about 100 microns. The length,  $l$  of the outlet portion 2 is preferably minimised whilst retaining a sufficient wall thickness " $t$ " to prevent plastic deformation upon use of the liquid transfer pin. It is preferably minimised because it is preferred that the volume of the outlet portion is negligible compared to the volume of the reservoir portion. The length of the reservoir portion is preferably in the range of 300 to 2000 microns, such as about 1000 microns.

The working end of the liquid transfer pin shown in Figures 1 and 3 is smoothly tapered towards the tip. Alternatively, it may be tapered in a step-wise manner or not tapered at all.

Furthermore, as shown in Figures 4 and 5 the liquid transfer pin shown in Figures 1 and 3 has a generally circular cross-sectional symmetry. The tip of the liquid transfer pin is squared off and preferably has a diameter in the range of 50 to 200 microns, such as 100, 150 or 200 microns. However, the present invention is not limited to liquid transfer pins having a circular cross-sectional symmetry, and the present invention may be applied to pins having non-circular cross-sectional symmetry such as a tapered or non-tapered thin blade-shaped pin having a generally rectangular cross-section.

Since the resultant liquid transfer pin has the required small dimensions without having to subject the liquid transfer pin to subsequent plastic deformation, liquid transfer pins produced according to this method have consistent dimensions. This consistency means that the liquid transfer pin of the present invention is

particularly useful for producing a multi-pin liquid transfer tool as schematically shown in Figure 6 to be used for simultaneously creating an array of a large number of small droplets of uniform size. In Figure 6, a plurality of liquid transfer pins 10 having working ends as shown in Figures 1 and 3 are orderly arranged on a common base 12, such that the tips of the plurality of liquid transfer pins lie in a single horizontal plane.

The liquid transfer pin of the present invention is used in the conventional manner. The liquid transfer pin is dipped into a source of the sample fluid whereby the outlet portion and reservoir portions become at least partially filled with the sample fluid. The tip of the liquid transfer pin is then tapped against the substrate on which the array is to be formed by relative movement of the tip of the pin towards the substrate to transfer a droplet of the sample fluid from the tip of the liquid transfer pin to the substrate. The tip of the liquid transfer pin is then repeatedly tapped at different portions of the surface of the substrate to form an ordered array of spots on the surface of the substrate.

The liquid transfer pin generally shown in Figures 1 and 3 exhibits excellent performance with respect to consistency of droplet volume with increasing spot number, as shown in the graph in Figure 2. The intensity given on the y-axis is directly proportional to the volume of the droplet dispensed on the substrate. As can be seen from the graph, the volume dispensed is substantially consistent until the very last few spots with a very sharp reduction in dispensed volume for those last few spots. This is in contrast to conventional liquid transfer pins in which the tail-off is much

shallower whereby the dispensed volume is consistent for a smaller proportion of the total number of spots.

## CLAIMS

1. A method of producing a liquid transfer pin having a tip and defining a slot extending from the tip for transferring one or more drops of a fluid to a substrate, the slot comprising an elongate outlet portion extending from the tip and a reservoir portion connected to a distal end of the outlet portion and having a larger cut-out volume than that of the outlet portion, said method comprising the step of cutting the slot into a tip of a solid pin, wherein the width of the outlet portion at the tip is no more than 20 microns directly after cutting.
2. A method of producing a liquid transfer pin according to claim 1 wherein the width of the slot at the tip is between 10 and 20 microns directly after cutting.
3. A method of producing a liquid transfer pin according to claim 1 or claim 2 wherein the outlet portion of the slot has a substantially axially uniform width.
4. A method of producing a liquid transfer pin according to claim 3 wherein the reservoir portion of the slot has a substantially axially uniform width larger than that of the outlet portion.
5. A method of producing a liquid transfer pin according to claim 1 wherein the liquid transfer pin is at least partially tapered towards the tip.

6. A method of producing a liquid transfer pin according to any preceding claim wherein the cutting is copper vapour laser cutting.

7. A method of producing a liquid transfer pin having a tip and defining a slot extending from the tip for transferring one or more drops of a fluid from the tip to a substrate, the slot comprising an elongate outlet portion extending from the tip and a reservoir portion connected to a distal end of the outlet portion and having a larger cut-out volume than that of the outlet portion, said method comprising using copper vapour laser cutting to form the slot in a tip of a solid tapered pin.

8. A method according to claim 7 wherein the width of the slot at the tip is no more than 20 microns.

9. A method according to claim 8 wherein the width of the slot at the tip is in the range of 10 to 20 microns.

10. A method according to any one of claims 7 to 9 wherein the elongate outlet portion has a substantially axially uniform width.

11. A method according to claim 10 wherein the reservoir portion has a substantially axially uniform width larger than that of the outlet portion.

12. A method according to claim 7 wherein the liquid transfer pin is at least partially tapered towards the tip.

13. A method according to claim 7 wherein the tip of the liquid transfer pin has a circular cross-section with a diameter in the range of 50 to 200 microns.

14. A liquid transfer pin produced by a method according to any of claims 1 to 13.

15. A liquid transfer pin for transferring one or more drops of a fluid to a substrate from a tip thereof, the liquid transfer pin defining a slot extending from the tip, wherein the slot comprises an elongate outlet portion extending from the tip, and a reservoir portion connected to a distal end of the outlet portion, the width of the reservoir portion being greater than the width of the outlet portion at the point where it is connected to the outlet portion.

16. A liquid transfer pin according to claim 15 wherein the width of the outlet portion at the tip is no more than 20 microns.

17. A liquid transfer pin according to claim 16 wherein the width of the outlet portion at the tip is in the range of 10 to 20 microns.

18. A liquid transfer pin according to any of claims 15 to 17 wherein the outlet portion has a substantially axially uniform width.

19. A liquid transfer pin according to any of claims 15 to 18 wherein the reservoir portion has a substantially axially uniform width.

20. A liquid transfer pin for transferring one or more drops of a fluid to a substrate from a tip thereof, the liquid transfer pin defining a slot extending from the tip, wherein the slot comprises an outlet portion extending from the tip and having a substantially axially uniform width, and a reservoir portion connected to a distal end of the outlet portion and having a substantially axially uniform width, the width of the outlet portion being less than the width of the reservoir portion.

21. A liquid transfer pin according to claim 20 wherein the width of the outlet portion is no more than 20 microns.

22. A liquid transfer pin according to claim 21 wherein the width of the outlet portion is in the range of 10 to 20 microns.

23. A liquid transfer pin for transferring one or more drops of a fluid to a substrate from a tip thereof, the liquid transfer pin defining a slot extending from the tip, wherein the slot comprises an outlet portion having a substantially axially uniform width of less than 20 microns, and a reservoir portion connected to a distal end of the outlet portion and having a larger capacity than the outlet portion.

24. A liquid transfer pin according to claim 23 wherein the width of the outlet portion is in the range of 10 to 20 microns.

25. A liquid transfer pin according to claim 24 wherein the reservoir portion also has a substantially axially uniform width.
26. A multi-pin liquid transfer tool comprising a plurality of liquid transfer pins according to any of claims 14 to 25 attached to a common base.
27. A method of producing a multi-pin liquid transfer tool by attaching a plurality of liquid transfer pins to a common base, each liquid transfer pin having a tip and defining a slot extending from the tip, wherein each liquid transfer pin is produced by cutting a slot into a tip of a solid pin, the width of the slot at the tip being less than 20 microns directly after cutting.
28. A method of producing a multi-pin liquid transfer tool by attaching a plurality of liquid transfer pins to a common base, each liquid transfer pin having a tip and defining a slot extending from the tip, wherein each liquid transfer pin is produced by cutting a slot into a tip of a solid pin by copper vapour laser cutting.
29. A multi-pin liquid transfer tool produced by the method defined in claim 27 or claim 28.
30. A method of producing an ordered array of spots on a substrate using a liquid transfer pin according to any one of claims 15 to 25 or a multi-pin liquid transfer tool according to claim 26 or claim 29.
31. A method of producing an ordered array of spots according to claim 30 wherein the diameter of the spots is in the range of 50 to 200 microns.



32. A method of transferring one or more drops of liquid to one or more substrates using a liquid transfer pin, wherein the liquid transfer pin has a tip and defines a slot extending from the tip and is produced by cutting a slot into a tip of a solid pin, wherein the width of the slot at the tip is no more than 20 microns directly after cutting.

33. A method of transferring one or more drops of liquid to one or more substrates using a liquid transfer pin, wherein the liquid transfer pin has a tip and defines a slot extending from the tip and is produced by cutting a slot into a tip of a solid pin by copper vapour laser cutting.

34. A liquid transfer pin substantially as hereinbefore described with reference to any of Figures 1 and 3 to 5 of the accompanying drawings.

35. A multi-pin liquid transfer tool substantially as hereinbefore described with reference to Figure 6 and any of Figures 1 and 3 to 5 of the accompanying drawings.

# INTERNATIONAL SEARCH REPORT

Intern. Application No.  
PCT/L 0/02678

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 B01L3/02

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 B01L GOIN

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.                       |
|------------|--|---|
| E          | US 6 101 946 A (MARTINSKY RICHARD S)<br>15 August 2000 (2000-08-15)<br>abstract; figures 2-4,6,7<br>column 3, line 13 -column 3, line 41<br>column 4, line 24 -column 5, line 44<br>column 6, line 45 -column 6, line 67   | 1-33  |
| P,A        | WO 00 25923 A (DAVIES MARTIN CLEMENT<br>;ELMES STUART ANTONY (GB); MILNE WILLIAM<br>IRE) 11 May 2000 (2000-05-11)<br><br>abstract; figures 8,10,11<br>page 1, line 1 -page 1, line 18<br>page 5, line 9 -page 5, line 16<br>page 7, line 8 -page 7, line 28<br><br>-/- | 1,7,14,<br>15,20,<br>23,<br>26-30,<br>32,33 |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
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- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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- "&" document member of the same patent family

Date of the actual completion of the international search

11 October 2000

Date of mailing of the international search report

17/10/2000

Name and mailing address of the ISA

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Fax (+31-70) 340-3018

Authorized officer

Runser, C

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/02678

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.                       |
|------------|--|---|
| A          | US 5 770 151 A (ROACH DAVID J ET AL)<br>23 June 1998 (1998-06-23)<br>abstract; figures 2-6<br>column 4, line 5 -column 5, line 50                | 1-33  |
| A          | WO 99 31468 A (FEYGIN ILYA ;PHARMACOEPIA<br>INC (US)) 24 June 1999 (1999-06-24)<br>abstract; figures 1-8<br>page 4, line 17 -page 8, line 11     | 1-33  |
| A          | US 5 807 522 A (BROWN PATRICK O ET AL)<br>15 September 1998 (1998-09-15)<br>abstract; figures 1-3<br>column 7, line 17 -column 9, line 62        | 1-33  |
| P,A        | WO 00 01798 A (CARTESIAN TECHNOLOGIES INC)<br>13 January 2000 (2000-01-13)<br>abstract; figures 1-3<br>page 5, line 28 -page 9, line 30          | 1-33  |
| A          | US 3 616 387 A (SIEBERT CHRISTOPHER J ET<br>AL) 26 October 1971 (1971-10-26)<br><br>abstract; figures 6,7<br>column 4, line 41 -column 5, line 8 | 1,7,14,<br>15,20,<br>23,<br>26-30,<br>32,33 |

# INTERNATIONAL SEARCH REPORT

Automatic Patent family members

Inter Application No  
PCT/ 00/02678

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s)  | Publication<br>date  |
|---|---|---------------------|---|--|
| US 6101946                                | A | 15-08-2000          | NONE  |  |
| WO 0025923                                | A | 11-05-2000          | NONE  |  |
| US 5770151                                | A | 23-06-1998          | EP 0991472 A<br>WO 9746319 A  | 12-04-2000<br>11-12-1997   |
| WO 9931468                                | A | 24-06-1999          | US 5957167 A<br>AU 1923299 A<br>US 6116297 A  | -<br>28-09-1999<br>05-07-1999<br>12-09-2000  |
| US 5807522                                | A | 15-09-1998          | AT 180570 T<br>AU 709276 B<br>AU 2862995 A<br>CA 2192095 A<br>DE 69509925 D<br>DE 69509925 T<br>EP 0804731 A<br>EP 0913485 A<br>ES 2134481 T<br>GR 3030430 T<br>JP 10503841 T<br>US 6110426 A<br>WO 9535505 A | 15-06-1999<br>26-08-1999<br>15-01-1996<br>28-12-1995<br>01-07-1999<br>09-12-1999<br>05-11-1997<br>06-05-1999<br>01-10-1999<br>30-09-1999<br>07-04-1998<br>29-08-2000<br>28-12-1995 |
| WO 0001798                                | A | 13-01-2000          | AU 4861099 A  | 24-01-2000   |
| US 3616387                                | A | 26-10-1971          | DE 2055948 A<br>FR 2071887 A<br>GB 1333926 A  | 19-05-1971<br>17-09-1971<br>17-10-1973   |

1 / 4

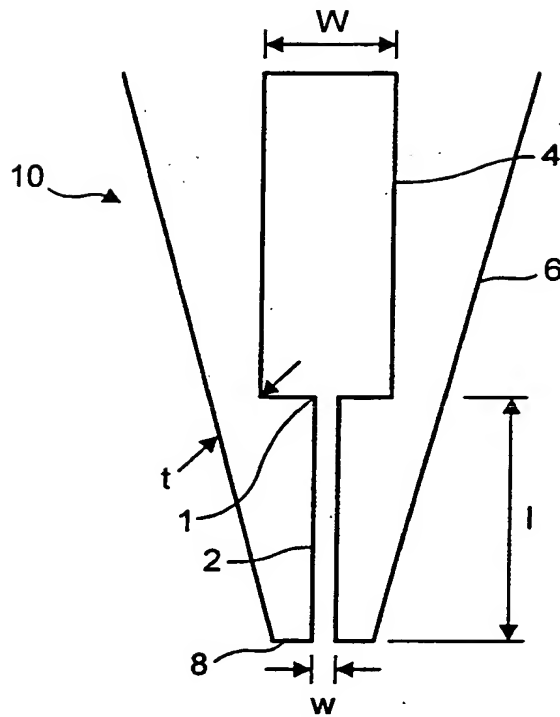


FIG. 1

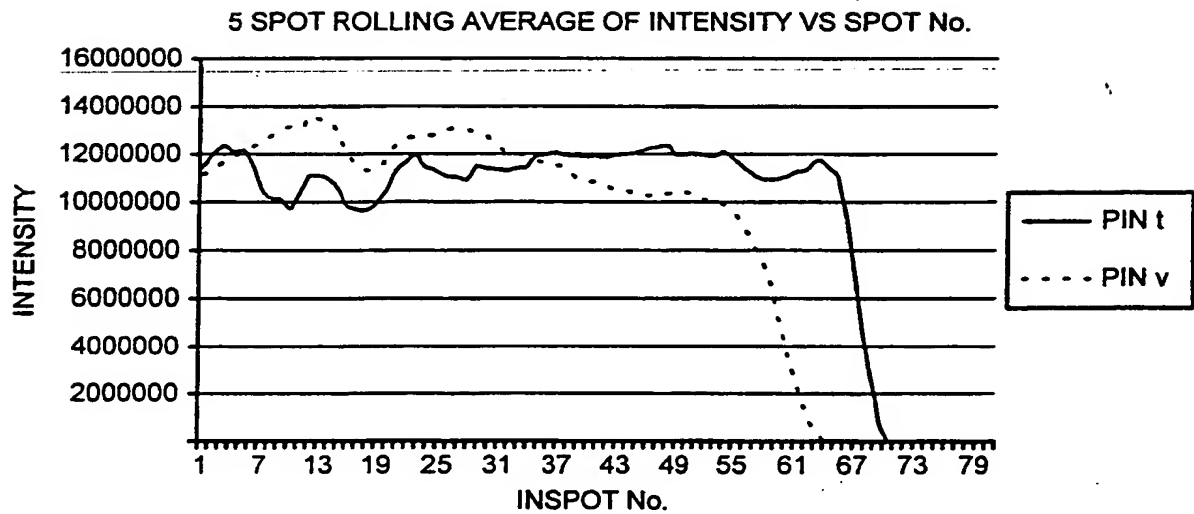


FIG. 2

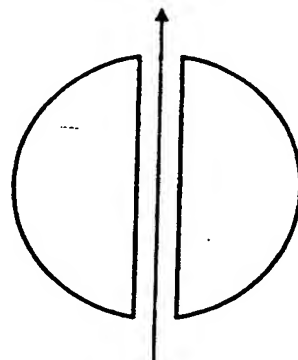
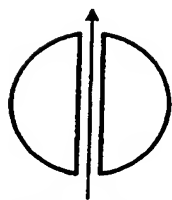
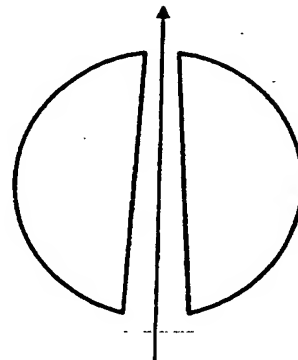
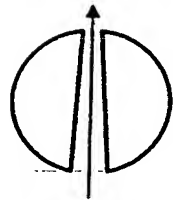
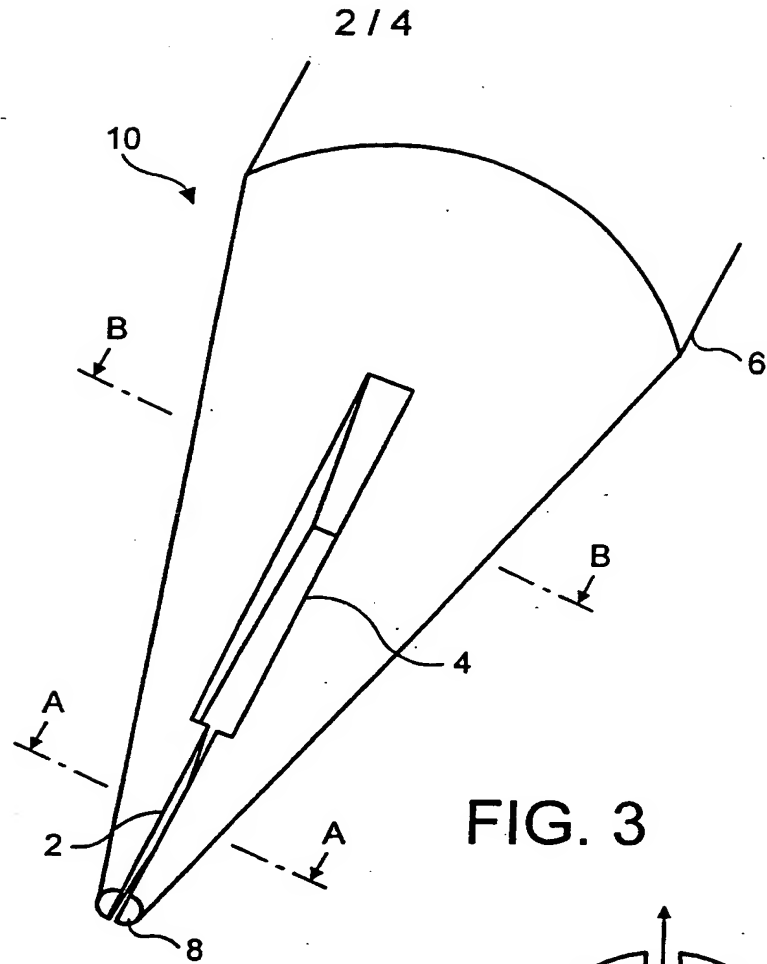


FIG. 5(a)

FIG. 5(b)

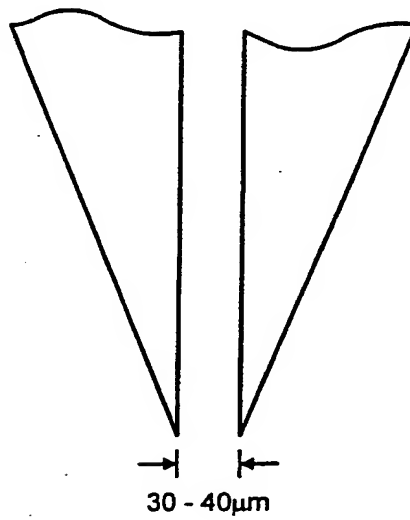
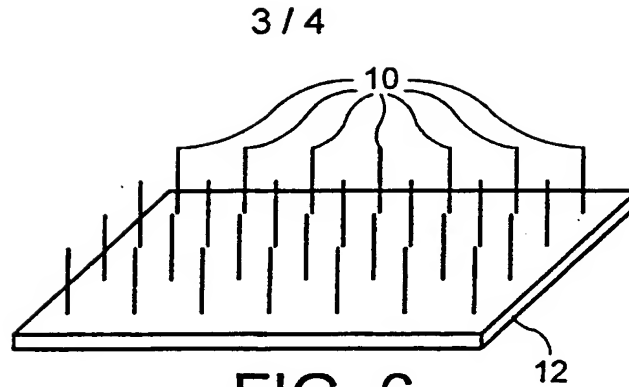


FIG. 7(a)

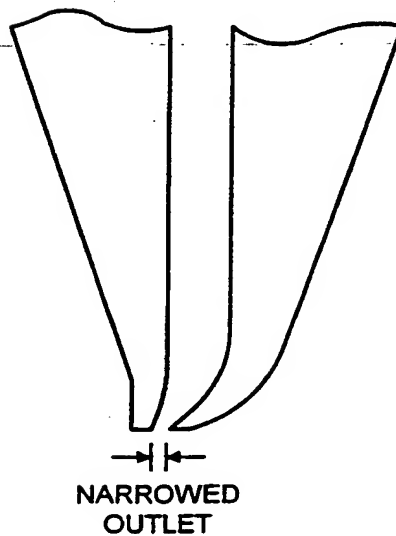


FIG. 7(b)

4 / 4

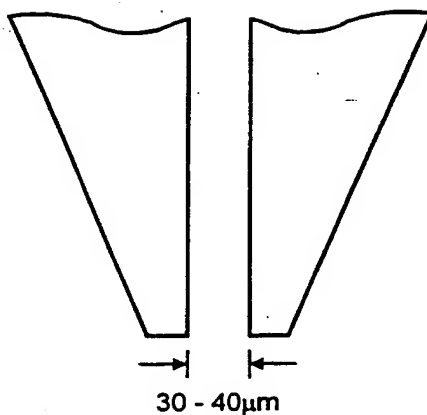


FIG. 8(a)

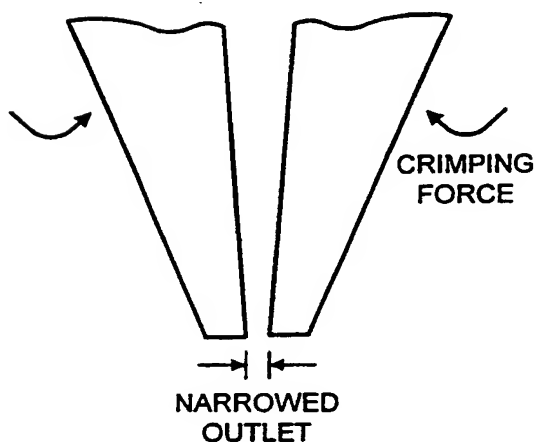


FIG. 8(b)

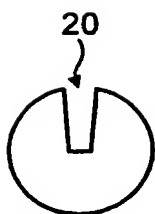


FIG. 9(a)

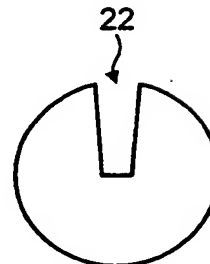


FIG. 9(b)



# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

|  |   |  |   |
|--|---|--|---|
| Applicant's or agent's file reference<br><b>102316/VRD/MNE</b> | <b>FOR FURTHER ACTION</b>                                       |  | see Notification of Transmittal of International Search Report<br>(Form PCT/ISA/220) as well as, where applicable, item 5 b. low. |
| International application No.<br><b>PCT/GB 00/ 02678</b>       | International filing date (day/month/year)<br><b>12/07/2000</b> | (Earliest) Priority Date (day/month/year)<br><b>13/07/1999</b> |   |
| Applicant<br><br><b>BIOROBOTICS LIMITED</b>                    |   |  |   |

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

**1. Basis of the report**

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (see Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☐ the text is approved as submitted by the applicant.

☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1  
☐ None of the figures.

## Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A method of producing a liquid transfer pin (10) having a tip (8) and defining a slot (1) extending from the tip (8) for transferring one or more drops of a fluid to a substrate, the slot comprising an elongate outlet portion (12) extending from the tip (8) and a reservoir portion (4) connected to a distal end of the outlet portion and having a larger cut-out volume than that of the outlet portion, said method comprising the step of cutting the slot into a tip of a solid pin, wherein the width of the outlet portion at the tip is no more than 20 microns directly after cutting.

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/02678

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B01L3/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B01L G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.                       |
|------------|--|---|
| E          | US 6 101 946 A (MARTINSKY RICHARD S)<br>15 August 2000 (2000-08-15)<br>abstract; figures 2-4,6,7<br>column 3, line 13 -column 3, line 41<br>column 4, line 24 -column 5, line 44<br>column 6, line 45 -column 6, line 67<br>---  | 1-33  |
| P,A        | WO 00 25923 A (DAVIES MARTIN CLEMENT<br>;ELMES STUART ANTONY (GB); MILNE WILLIAM<br>IRE) 11 May 2000 (2000-05-11)<br><br>abstract; figures 8,10,11<br>page 1, line 1 -page 1, line 18<br>page 5, line 9 -page 5, line 16<br>page 7, line 8 -page 7, line 28<br>---<br>-/-- | 1,7,14,<br>15,20,<br>23,<br>26-30,<br>32,33 |

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search

11 October 2000

Date of mailing of the international search report

17/10/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Runser, C

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 00/02678

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.                       |
|------------|---|---|
| A          | US 5 770 151 A (ROACH DAVID J ET AL)<br>23 June 1998 (1998-06-23)<br>abstract; figures 2-6<br>column 4, line 5 -column 5, line 50<br>----                 | 1-33  |
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| A          | US 5 807 522 A (BROWN PATRICK O ET AL)<br>15 September 1998 (1998-09-15)<br>abstract; figures 1-3<br>column 7, line 17 -column 9, line 62<br>----         | 1-33  |
| P,A        | WO 00 01798 A (CARTESIAN TECHNOLOGIES INC)<br>13 January 2000 (2000-01-13)<br>abstract; figures 1-3<br>page 5, line 28 -page 9, line 30<br>----           | 1-33  |
| A          | US 3 616 387 A (SIEBERT CHRISTOPHER J ET<br>AL) 26 October 1971 (1971-10-26)<br><br>abstract; figures 6,7<br>column 4, line 41 -column 5, line 8<br>----- | 1,7,14,<br>15,20,<br>23,<br>26-30,<br>32,33 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/98/00/02678

| Patent document cited in search report | Publication date | Patent family member(s)   | Publication date   |
|--|------------------|---|--|
| US 6101946 A                           | 15-08-2000       | NONE  |  |
| WO 0025923 A                           | 11-05-2000       | NONE  |  |
| US 5770151 A                           | 23-06-1998       | EP 0991472 A<br>WO 9746319 A  | 12-04-2000<br>11-12-1997   |
| WO 9931468 A                           | 24-06-1999       | US 5957167 A<br>AU 1923299 A<br>US 6116297 A  | 28-09-1999<br>05-07-1999<br>12-09-2000   |
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| WO 0001798 A                           | 13-01-2000       | AU 4861099 A  | 24-01-2000   |
| US 3616387 A                           | 26-10-1971       | DE 2055948 A<br>FR 2071887 A<br>GB 1333926 A  | 19-05-1971<br>17-09-1971<br>17-10-1973   |

# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

|  |  |  |
|--|--|--|
| Applicant's or agent's file reference<br><b>102316/VRD/MNE</b> | <b>FOR FURTHER ACTION</b> <small>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</small> |  |
| International application No.<br><b>PCT/GB 00/ 02678</b>       | International filing date (day/month/year)<br><b>12/07/2000</b>  | (Earliest) Priority Date (day/month/year)<br><b>13/07/1999</b> |
| Applicant<br><br><b>BIOROBOTICS LIMITED</b>                    |  |  |

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- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

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- ☐ the text has been established by this Authority to read as follows:

**5. With regard to the abstract,**

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6. The figure of the **drawings** to be published with the abstract is Figure No.

- ☒ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
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☐ None of the figures.

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## INTERNATIONAL SEARCH REPORT

International Application No

P0003 00/02678

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B01L3/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B01L G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

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|------------|--|---|
| E          | US 6 101 946 A (MARTINSKY RICHARD S)<br>15 August 2000 (2000-08-15)<br>abstract; figures 2-4,6,7<br>column 3, line 13 -column 3, line 41<br>column 4, line 24 -column 5, line 44<br>column 6, line 45 -column 6, line 67   | 1-33  |
| P,A        | WO 00 25923 A (DAVIES MARTIN CLEMENT<br>;ELMES STUART ANTONY (GB); MILNE WILLIAM<br>IRE) 11 May 2000 (2000-05-11)<br><br>abstract; figures 8,10,11<br>page 1, line 1 -page 1, line 18<br>page 5, line 9 -page 5, line 16<br>page 7, line 8 -page 7, line 28<br><br>---<br>-/-- | 1,7,14,<br>15,20,<br>23,<br>26-30,<br>32,33 |

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&amp;" document member of the same patent family

Date of the actual completion of the international search

11 October 2000

Date of mailing of the international search report

17/10/2000

Name and mailing address of the ISA

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Authorized officer

Runser, C



## INTERNATIONAL SEARCH REPORT

International Application No

PO 8 00/02678

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.                       |
|------------|---|---|
| A          | US 5 770 151 A (ROACH DAVID J ET AL)<br>23 June 1998 (1998-06-23)<br>abstract; figures 2-6<br>column 4, line 5 -column 5, line 50<br>-----                | 1-33  |
| A          | WO 99 31468 A (FEYGIN ILYA ;PHARMACOEPIA<br>INC (US)) 24 June 1999 (1999-06-24)<br>abstract; figures 1-8<br>page 4, line 17 -page 8, line 11<br>-----     | 1-33  |
| A          | US 5 807 522 A (BROWN PATRICK O ET AL)<br>15 September 1998 (1998-09-15)<br>abstract; figures 1-3<br>column 7, line 17 -column 9, line 62<br>-----        | 1-33  |
| P,A        | WO 00 01798 A (CARTESIAN TECHNOLOGIES INC)<br>13 January 2000 (2000-01-13)<br>abstract; figures 1-3<br>page 5, line 28 -page 9, line 30<br>-----          | 1-33  |
| A          | US 3 616 387 A (SIEBERT CHRISTOPHER J ET<br>AL) 26 October 1971 (1971-10-26)<br><br>abstract; figures 6,7<br>column 4, line 41 -column 5, line 8<br>----- | 1,7,14,<br>15,20,<br>23,<br>26-30,<br>32,33 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

P B 00/02678

| Patent document cited in search report |   | Publication date | Patent family member(s) |            | Publication date |
|--|---|------------------|-------------------------|------------|------------------|
| US 6101946                             | A | 15-08-2000       | NONE                    |            |                  |
| WO 0025923                             | A | 11-05-2000       | NONE                    |            |                  |
| US 5770151                             | A | 23-06-1998       | EP                      | 0991472 A  | 12-04-2000       |
|  |   |                  | WO                      | 9746319 A  | 11-12-1997       |
| WO 9931468                             | A | 24-06-1999       | US                      | 5957167 A  | 28-09-1999       |
|  |   |                  | AU                      | 1923299 A  | 05-07-1999       |
|  |   |                  | US                      | 6116297 A  | 12-09-2000       |
| US 5807522                             | A | 15-09-1998       | AT                      | 180570 T   | 15-06-1999       |
|  |   |                  | AU                      | 709276 B   | 26-08-1999       |
|  |   |                  | AU                      | 2862995 A  | 15-01-1996       |
|  |   |                  | CA                      | 2192095 A  | 28-12-1995       |
|  |   |                  | DE                      | 69509925 D | 01-07-1999       |
|  |   |                  | DE                      | 69509925 T | 09-12-1999       |
|  |   |                  | EP                      | 0804731 A  | 05-11-1997       |
|  |   |                  | EP                      | 0913485 A  | 06-05-1999       |
|  |   |                  | ES                      | 2134481 T  | 01-10-1999       |
|  |   |                  | GR                      | 3030430 T  | 30-09-1999       |
|  |   |                  | JP                      | 10503841 T | 07-04-1998       |
|  |   |                  | US                      | 6110426 A  | 29-08-2000       |
|  |   |                  | WO                      | 9535505 A  | 28-12-1995       |
| WO 0001798                             | A | 13-01-2000       | AU                      | 4861099 A  | 24-01-2000       |
| US 3616387                             | A | 26-10-1971       | DE                      | 2055948 A  | 19-05-1971       |
|  |   |                  | FR                      | 2071887 A  | 17-09-1971       |
|  |   |                  | GB                      | 1333926 A  | 17-10-1973       |

# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

|  |   |  |
|--|---|--|
| Applicant's or agent's file reference<br>102316/VRD/MNE                                  | <b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |  |
| International application No.<br>PCT/GB00/02678  | International filing date (day/month/year)<br>12/07/2000  | Priority date (day/month/year)<br>13/07/1999 |
| International Patent Classification (IPC) or national classification and IPC<br>B01L3/02 |   |  |
| Applicant<br>BIOROBOTICS LIMITED   |   |  |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 8 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☒ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☒ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

|   |   |
|---|---|
| Date of submission of the demand<br><br>12/02/2001  | Date of completion of this report<br><br>19.10.2001   |
| Name and mailing address of the international preliminary examining authority:<br><br> European Patent Office<br>D-80298 Munich<br>Tel. +49 89 2399 - 0 Tx: 523656 epmu d<br>Fax: +49 89 2399 - 4465 | Authorized officer<br><br>de Biasio, A<br><br>Telephone No. +49 89 2399 8627<br><br> |

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02678

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

### Description, pages:

1-14 as originally filed

### Claims, No.:

1-35 as originally filed

### Drawings, sheets:

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02678

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-14,20-35.

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 1-35 are so unclear that no meaningful opinion could be formed (*specify*):  
**see separate sheet**

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

## IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02678

- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.
2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is
- ☐ complied with.
- ☒ not complied with for the following reasons:  
**see separate sheet**
4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:
- ☐ all parts.
- ☒ the parts relating to claims Nos. 15-19.

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

|                               |      |        |       |
|-------------------------------|------|--------|-------|
| Novelty (N)                   | Yes: | Claims | 15-19 |
|                               | No:  | Claims | -     |
| Inventive step (IS)           | Yes: | Claims | -     |
|                               | No:  | Claims | 15-19 |
| Industrial applicability (IA) | Yes: | Claims | 15-19 |
|                               | No:  | Claims | -     |

### 2. Citations and explanations **see separate sheet**

## VI. Certain documents cited

### 1. Certain published documents (Rule 70.10)

and / or

### 2. Non-written disclosures (Rule 70.9)

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB00/02678

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**VIII. Certain observations on the International application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**Re Item III, IV, V and VIII:**

1. Present claims 1-35 are drafted in a style which is not acceptable for the reasons given below:
  - 1.1 Contrary to the requirements of Article 6 PCT, the plurality of varying definitions of the subject-matter on question, as found in independent claims 1, 7, 14, 15, 20, 23, 26, 27, 30 and 32 is such that the claims as a whole are not concise.  
The set of claims should define the relevant subject-matter in terms of a minimum number of independent claims in each category (Rule 6.1 PCT) followed by dependent claims covering features which are merely optional (Rule 6.4 PCT). In this case one claim per category would seem appropriate.
  - 1.2 An assessment of the inventive step of an application is always preceded by the determination of the technical problem based on objective criteria, i.e. the well known 'problem-solution-approach'.

The examiner must then, inter alia, determine whether, in the light of the closest prior art, the independent claim comprises the essential features necessary to solve this objective technical problem (Article 6 PCT).

However, the widely varying combinations of (unrelated) technical features in the present independent claims precludes the determination of the objective technical problem. In other words the independent claims render each other unclear as to the essential features of the invention (Article 6 PCT).

Furthermore, the presence of different combinations of features in the same category is considered an indication that the applicant himself is not certain either where the patentable invention lies or which features comprise new and inventive subject-matter in the sense of Article 33 (2) and (3) PCT.

- 1.3 The applicant's attention is further drawn to Rule 13.1 PCT which requires a single inventive concept to the present application. This requirement is not met by the present application since the technical relationship between the subject-matter of claims 1 and 7, of claims 14, 15, 20 and 23 and of claims 30 and 32 as required by Rule 13.2 is lacking.

In this cases different concepts are present. It is therefore not clear as to which technical problem should be solved by the present application (Article 6 PCT).



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

---

International application No. PCT/GB00/02678

2. Beside the above mentioned deficiencies, further lacks of clarity (Article 6 PCT) have been found in the present application:
  - 2.1 The method claims 1-13 mainly contain product features. None of the independent method claims 1 and 7 comprise all the features necessary to produce the liquid transfer pin.
  - 2.2 The liquid transfer pin of claim 14 is merely defined by the process of manufacturing. In this case this kind of definition ("product by process") does not seem appropriate.

This applies also to claims 26 and 29.
  - 2.3 The use claims 32 and 33 mainly contain repetitions of product features or manufacturing process features.
  - 2.4 The claims 34 and 35 only contain references to drawings and cannot be allowed (Rule 6.2 (a) PCT).

3. As claim 15 seems to be the claim conferring the broadest scope of protection, it has been examined under Art. 33(2) and (3) PCT.

The document WO 99/31468 (D1), which appears to provide the closest state of the art with respect to claim 15, discloses (see Fig. 6 and Fig. 7) a liquid transfer pin (300a/b/c) for transferring one or more drops of a fluid to a substrate from a tip thereof, the liquid transfer pin defining a slot extending from the tip, wherein the slot comprises an elongate outlet portion extending from the tip, and a reservoir portion connected to a distal end of the outlet portion.

The liquid transfer pin of claim 15 differs from what is disclosed in D1 in that the width of the reservoir portion is greater than the width of the outlet portion at the point where it is connected to the outlet portion. However, the maximum width of the reservoir portion in the liquid transfer pin of D1 is larger than that of the outlet portion and is considered equivalent to feature of claim 15. Hence, the object of claim 15 does not involve an inventive step (Article 33 (3) PCT).

The subject matters of dependent claims 16-19 also seem to lack an inventive step (Article 33 (3) PCT).

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB00/02678

**Re Item VI:**

Reference is made to the documents US-A 6.101.946 and WO 00/25923 cited in the search report. These documents were published after the priority date of the present application, but could be relevant under Rule 64(3) PCT.


Both documents disclose liquid transfer pins with a slot extending from the tip. The slot comprises an elongate outlet portion extending from the tip and a reservoir portion connected to a distal end of the outlet portion. Both documents also consider the use of laser beams to cut the slot into the pin.

**Re Item VII:**

1. At page 8, last paragraph, it is advisable to identify the stainless steel grade "17-04ph" (17% Cr - 4% Ni - phase hardening?) with a designation of common use (e.g. EN, DIN, BS, ASTM, UNS etc.).
2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

|  |  |   |  |
|--|--|---|--|
| Applicant's or agent's file reference<br>102316/VRD/MNE  |  | <b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |  |
| International application No.<br>PCT/GB00/02678  | International filing date (day/month/year)<br>12/07/2000 | Priority date (day/month/year)<br>13/07/1999  |  |
| International Patent Classification (IPC) or national classification and IPC<br>B01L3/02   |  |   |  |
| Applicant<br>BIOROBOTICS LIMITED   |  |   |  |
| <p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 8 sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of sheets.</p>  |  |   |  |
| <p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"><li>I <input checked="" type="checkbox"/> Basis of the report</li><li>II <input type="checkbox"/> Priority</li><li>III <input checked="" type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li><li>IV <input checked="" type="checkbox"/> Lack of unity of invention</li><li>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li><li>VI <input checked="" type="checkbox"/> Certain documents cited</li><li>VII <input checked="" type="checkbox"/> Certain defects in the international application</li><li>VIII <input checked="" type="checkbox"/> Certain observations on the international application</li></ul> |  |   |  |
| Date of submission of the demand<br>12/02/2001   |  | Date of completion of this report<br>19.10.2001   |  |
| Name and mailing address of the international preliminary examining authority:<br> European Patent Office<br>D-80298 Munich<br>Tel. +49 89 2399 - 0 Tx: 523656 epmu d<br>Fax: +49 89 2399 - 4465  |  | Authorized officer<br><br>de Biasio, A<br><br>Telephone No. +49 89 2399 8627  |  |



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02678

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, pages:**

1-14 as originally filed

**Claims, No.:**

1-35 as originally filed

**Drawings, sheets:**

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02678

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

### III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-14,20-35.

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 1-35 are so unclear that no meaningful opinion could be formed (*specify*):  
**see separate sheet**

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

### IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02678

- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.
- 2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.
- 3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is
  - ☐ complied with.
  - ☒ not complied with for the following reasons:  
**see separate sheet**
- 4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:
  - ☐ all parts.
  - ☒ the parts relating to claims Nos. 15-19.

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

|                               |      |        |       |
|-------------------------------|------|--------|-------|
| Novelty (N)                   | Yes: | Claims | 15-19 |
|                               | No:  | Claims | -     |
| Inventive step (IS)           | Yes: | Claims | -     |
|                               | No:  | Claims | 15-19 |
| Industrial applicability (IA) | Yes: | Claims | 15-19 |
|                               | No:  | Claims | -     |

2. Citations and explanations  
**see separate sheet**

## VI. Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB00/02678

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**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**Re Item III, IV, V and VIII:**

1. Present claims 1-35 are drafted in a style which is not acceptable for the reasons given below:

1.1 Contrary to the requirements of Article 6 PCT, the plurality of varying definitions of the subject-matter on question, as found in independent claims 1, 7, 14, 15, 20, 23, 26, 27, 30 and 32 is such that the claims as a whole are not concise. The set of claims should define the relevant subject-matter in terms of a minimum number of independent claims in each category (Rule 6.1 PCT) followed by dependent claims covering features which are merely optional (Rule 6.4 PCT). In this case one claim per category would seem appropriate.

1.2 An assessment of the inventive step of an application is always preceded by the determination of the technical problem based on objective criteria, i.e. the well known 'problem-solution-approach'.

The examiner must then, inter alia, determine whether, in the light of the closest prior art, the independent claim comprises the essential features necessary to solve this objective technical problem (Article 6 PCT).

However, the widely varying combinations of (unrelated) technical features in the present independent claims precludes the determination of the objective technical problem. In other words the independent claims render each other unclear as to the essential features of the invention (Article 6 PCT).

Furthermore, the presence of different combinations of features in the same category is considered an indication that the applicant himself is not certain either where the patentable invention lies or which features comprise new and inventive subject-matter in the sense of Article 33 (2) and (3) PCT.

1.3 The applicant's attention is further drawn to Rule 13.1 PCT which requires a single inventive concept to the present application. This requirement is not met by the present application since the technical relationship between the subject-matter of claims 1 and 7, of claims 14, 15, 20 and 23 and of claims 30 and 32 as required by Rule 13.2 is lacking.

In this cases different concepts are present. It is therefore not clear as to which technical problem should be solved by the present application (Article 6 PCT).



2. Beside the above mentioned deficiencies, further lacks of clarity (Article 6 PCT) have been found in the present application:
- 2.1 The method claims 1-13 mainly contain product features. None of the independent method claims 1 and 7 comprise all the features necessary to produce the liquid transfer pin.
- 2.2 The liquid transfer pin of claim 14 is merely defined by the process of manufacturing. In this case this kind of definition ("product by process") does not seem appropriate.
- This applies also to claims 26 and 29.
- 2.3 The use claims 32 and 33 mainly contain repetitions of product features or manufacturing process features.
- 2.4 The claims 34 and 35 only contain references to drawings and cannot be allowed (Rule 6.2 (a) PCT).

3. As claim 15 seems to be the claim conferring the broadest scope of protection, it has been examined under Art. 33(2) and (3) PCT.

The document WO 99/31468 (D1), which appears to provide the closest state of the art with respect to claim 15, discloses (see Fig. 6 and Fig. 7) a liquid transfer pin (300a/b/c) for transferring one or more drops of a fluid to a substrate from a tip thereof, the liquid transfer pin defining a slot extending from the tip, wherein the slot comprises an elongate outlet portion extending from the tip, and a reservoir portion connected to a distal end of the outlet portion.

The liquid transfer pin of claim 15 differs from what is disclosed in D1 in that the width of the reservoir portion is greater than the width of the outlet portion at the point where it is connected to the outlet portion. However, the maximum width of the reservoir portion in the liquid transfer pin of D1 is larger than that of the outlet portion and is considered equivalent to feature of claim 15. Hence, the object of claim 15 does not involve an inventive step (Article 33 (3) PCT).

The subject matters of dependent claims 16-19 also seem to lack an inventive step (Article 33 (3) PCT).

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB00/02678

**Re Item VI:**

Reference is made to the documents US-A 6.101.946 and WO 00/25923 cited in the search report. These documents were published after the priority date of the present application, but could be relevant under Rule 64(3) PCT.

Both documents disclose liquid transfer pins with a slot extending from the tip. The slot comprises an elongate outlet portion extending from the tip and a reservoir portion connected to a distal end of the outlet portion. Both documents also consider the use of laser beams to cut the slot into the pin.

**Re Item VII:**

1. At page 8, last paragraph, it is advisable to identify the stainless steel grade "17-04ph" (17% Cr - 4% Ni - phase hardening?) with a designation of common use (e.g. EN, DIN, BS, ASTM, UNS etc.).
2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).